

## CLAIMS

1. A steering apparatus comprising a steering wheel 13 and a helm pump 10 that can be rotated in both the forward and reverse directions by operating said steering wheel 13 and discharges a liquid of a quantity proportional to the rotating angle provided as steering means on the steersman side, and double action cylinder means consisting of a cylinder 20, a piston 21 and a piston rod 22 provided on rudder 27 side of the ship as means for moving the rudder 27, with the steering means and the double action cylinder means being connected with each other by means of a hydraulic circuit, so that the entire liquid that is discharged from the helm pump 10 is introduced via the hydraulic circuit into one chamber of the cylinder 20 of the double action cylinder means and the same amount of liquid is discharged from the other chamber of the cylinder 20 so as to flow through the hydraulic circuit into the helm pump 10, thus constituting the hydraulic circuit having fully closed circuit construction as a whole and moving the rudder 27 by an amount corresponding to the amount of liquid introduced into said cylinder 20,

wherein pump means that generates the discharging pressure in the same direction as the discharging direction from the helm pump 10 against the resistive pressure from the oil hydraulic circuit generated during rotation of the helm pump 10 due to the operation of said steering wheel 13 is installed in series in part

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of the fully closed hydraulic circuit, so that the steering resistance of the steering wheel 13 is automatically reduced by means of the assistance of said pump means.

2. The steering apparatus according to claim 1, wherein a hydraulic circuit 14 comprising a pair of hydraulic circuits 14a, 14b connecting said steering means and the double action cylinder means is provided as said hydraulic circuit so that the entire liquid that is discharged from the helm pump 10 is introduced via one of said pair of hydraulic circuits 14a, 14b into one chamber of the cylinder 20 and the same amount of liquid is discharged from the other chamber of the cylinder 20 so as to flow through the other one of said pair of hydraulic circuits 14a, 14b into the helm pump 10, thus constituting the hydraulic circuit 14 having fully closed circuit constitution as a whole and moving the rudder 27 by an amount corresponding to the amount of liquid introduced into said cylinder 20,

wherein at least a hydraulic pump 30 capable of discharging in both ways is provided as said pump means, and said hydraulic pump 30 capable of discharging in both ways is installed in series in part of the fully closed hydraulic circuit, so that the steering resistance of the steering wheel 13 is automatically reduced by applying discharging pressure in the same direction as the discharging direction of the helm pump 10 corresponding to the operation of the steering wheel 13 by means of the assistance of

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said pump means that includes said hydraulic pump 30.

3. The steering apparatus according to claim 2, wherein the pump means that generates discharging pressure in the same direction as the discharging direction of the helm pump 10 has a pressure detector that detects the resistive pressure received when the helm pump 10 rotates to discharge the liquid, so that the motor drive circuit 41 of the hydraulic pump 30 is controlled with the discharging pressure that corresponds to the resistive pressure detected by said pressure detector.

4. The steering apparatus according to claim 2, wherein the pump means that generates discharging pressure in the same direction as the discharging direction from the helm pump 10 has a pressure detector that detects the resistive pressure received when the helm pump 10 rotates to discharge the liquid and a current detector that detects motor current of the hydraulic pump 30, so that the resistive pressure detected by the pressure detector and the actual discharging pressure of the hydraulic pump 30 detected by the current detector are compared and the motor drive circuit 41 of the hydraulic pump 30 is controlled according to the difference.

5. The steering apparatus according to claim 1, wherein a hydraulic circuit 14 comprising a pair of hydraulic circuits 14a, 14b connecting said steering means and the double action cylinder means

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is provided as said hydraulic circuit so that the entire liquid that is discharged from said helm pump 10 is introduced via one of said pair of hydraulic circuits 14a, 14b into one chamber of the cylinder 20 and the same amount of liquid is discharged from the other chamber of the cylinder 20 so as to flow through the other one of said pair of hydraulic circuits 14a, 14b into the helm pump 10, thus constituting the hydraulic circuit 14 having fully closed circuit constitution as a whole and moving the rudder 27 by an amount corresponding to the amount of liquid introduced into said cylinder 20,

wherein at least a pair of hydraulic pumps 30, 31 capable of discharging in both ways are provided as said pump means, and said pair of hydraulic pumps 30, 31 capable of discharging in both ways are installed in series in of said pair of hydraulic circuits 14a, 14b of the fully closed hydraulic circuit 14, so that the steering resistance of the steering wheel 13 is automatically reduced by applying the discharging pressure in the same direction as discharging direction from the helm pump 10 corresponding to the operation of the steering wheel 13 by means of said pump means including said pair of hydraulic pumps 30, 31.

6. The steering apparatus according to claim 5, wherein the pump means that generates the discharging pressure in the same direction as the discharging direction from the helm pump 10 has a pressure detector that detects the resistive pressure received when the

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helm pump 10 rotates to discharge the liquid, so that the motor drive circuit 41 that drives both the pair of hydraulic pumps 30, 31 is controlled with the discharging pressure that corresponds to the resistive pressure detected by said pressure detector.

7. The steering apparatus according to claim 5, wherein the pump means that generates the discharging pressure in the same direction as the discharging direction from the helm pump 10 has a pressure detector that detects the resistive pressure received when the helm pump 10 rotates to discharge the liquid and a current detector that detects motor current of the pair of hydraulic pumps 30, 31, so that the resistive pressure detected by the pressure detector and the actual discharging pressure of the hydraulic pumps 30, 31 detected by the current detector are compared and the motor drive circuit 41 of the pair of hydraulic pumps 30, 31 is controlled according to the difference.

8. The steering apparatus according to claim 1, wherein at least a hydraulic pump 32 capable of discharging in only one direction is provided as said pump means, said hydraulic pump 32 being installed in series in part of said fully closed hydraulic circuit 15, and such passage switching means is installed between said hydraulic pump 32 and said helm pump 10 that switches the passage amid said hydraulic circuit 15 according to the direction of discharging the liquid from said helm pump 10 thereby to connect

the liquid from the helm pump 10 to the suction side of said hydraulic pump 32 regardless of which direction said helm pump 10 discharges, so that the steering resistance of the steering wheel 13 is automatically reduced by applying the discharging pressure in the same direction as the discharging direction from the helm pump 10 corresponding to the operation of the steering wheel 13 by means of the assistance of said pump means that includes said hydraulic pump 32 and the passage switching means.

9. The steering apparatus as described in claim 8, wherein the pump means that generates the discharging pressure in the same direction as the discharging direction from the helm pump 10 has a pressure detector that detects the resistive pressure received when the helm pump 10 rotates to discharge the liquid, so that the motor drive circuit 41 of the hydraulic pump 32 is controlled with the discharging pressure that corresponds to the resistive pressure detected by said pressure detector.

10. The steering apparatus as described in claim 8, wherein the pump means that generates the discharging pressure in the same direction as the discharging direction from the helm pump 10 has a pressure detector that detects the resistive pressure received when the helm pump 10 rotates to discharge the liquid and a current detector that detects motor current of the hydraulic pump 32, so that the resistive pressure detected by the pressure detector and

the actual discharging pressure of the hydraulic pump 32 detected by the current detector are compared and the motor drive circuit 41 of the hydraulic pump 32 is controlled according to the difference.

11. A steering apparatus having, in addition to the constitution of claim 1, a hydraulic circuit 14 comprising a pair of hydraulic circuits 14a, 14b connecting said steering means and the double action cylinder means provided as said hydraulic circuit so that the entire liquid that is discharged from said helm pump 10 is introduced via one of said pair of hydraulic circuits 14a, 14b into one chamber of the cylinder 20 and the same amount of liquid is discharged from the other chamber of the cylinder 20 so as to flow through the other one of said pair of hydraulic circuits 14a, 14b into the helm pump 10, thus constituting the hydraulic circuit 14 having fully closed circuit constitution as a whole and moving the rudder 27 by an amount corresponding to the amount of liquid introduced into said cylinder 20,

wherein at least a hydraulic pump 32 capable of discharging only in one direction is provided as said pump means, said hydraulic pump 32 is installed in series in of said pair of hydraulic circuits 14a, 14b of the fully closed hydraulic circuit 14, a pair of such passage switching means are installed between said hydraulic pump 32 and said helm pump 10 and between the hydraulic pump 32 and the cylinder 20 that switches the passage amid said hydraulic

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circuit 15 according to the direction of discharging the liquid from said helm pump 10 thereby to connect the liquid from the helm pump 10 to the suction side of said hydraulic pump 32 regardless of which direction said helm pump 10 discharges, so that the steering resistance of the steering wheel 13 is automatically reduced by applying the discharging pressure in the same direction as the discharging direction from the helm pump 10 corresponding to the operation of the steering wheel 13 by means of said pump means including said hydraulic pump 32 and said pair of passage switching means.

12. The steering apparatus according to claim 11, wherein the pump means that generates the discharging pressure in the same direction as the discharging direction from the helm pump 10 has a pressure detector that detects the resistive pressure received when the helm pump 10 rotates to discharge the liquid, so that the motor drive circuit 41 that drives both the hydraulic pump 32 is controlled with the discharging pressure that corresponds to the resistive pressure detected by said pressure detector.

13. The steering apparatus according to claim 11, wherein the pump means that generates the discharging pressure in the same direction as the discharging direction from the helm pump 10 has a pressure detector that detects the resistive pressure received when the helm pump 10 rotates to discharge the liquid, and a current detector



that detects motor current of the hydraulic pump 32, so that the resistive pressure detected by the pressure detector and the actual discharging pressure of the hydraulic pump 32 detected by the current detector are compared and the motor drive circuit 41 of the hydraulic pump 32 is controlled according to the difference.

14. The steering apparatus according to claim 1, wherein a hydraulic circuit 14 comprising a pair of hydraulic circuits 14a, 14b connecting said steering means and the double action cylinder means is provided as said hydraulic circuit so that the entire liquid that is discharged from said helm pump 10 is introduced via one of said pair of hydraulic circuits 14a, 14b into one chamber of the cylinder 20 and the same amount of liquid is discharged from the other chamber of the cylinder 20 so as to flow through the other one of said pair of hydraulic circuits 14a, 14b into the helm pump 10, thus constituting the hydraulic circuit 14 having fully closed circuit constitution as a whole and moving the rudder 27 by an amount corresponding to the amount of liquid introduced into said cylinder 20,

wherein at least a pair of hydraulic pumps 33, 34 capable of discharging only in one direction are provided as said pump means, and said pair of hydraulic pumps 33, 34 capable of discharging only in one direction are installed in series in said pair of hydraulic circuits 14a, 14b of the fully closed hydraulic circuit 14, so that the resistance against the operation of the steering

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wheel 13 is automatically reduced by driving either one of said pair of hydraulic pumps 33, 34 in accordance to the direction of discharging the liquid from the helm pump 10 due to the operation of the steering wheel 13 and applying the discharging pressure in the same direction as the discharging direction from the helm pump 10 corresponding to the operation of the steering wheel 13.

15. The steering apparatus according to claim 14, wherein the pump means that generates the discharging pressure in the same direction as the discharging direction from the helm pump 10 has a pressure detector that detects the resistive pressure received when the helm pump 10 rotates to discharge the liquid, so that the motor drive circuit 41 that drives the hydraulic pumps 33, 34 is controlled with the discharging pressure that corresponds to the resistive pressure detected by said pressure detector.

16. The steering apparatus according to claim 14, wherein the pump means that generates the discharging pressure in the same direction as the discharging direction from the helm pump 10 has a pressure detector that detects the resistive pressure received when the helm pump 10 rotates to discharge the liquid, and a current detector that detects motor current of the hydraulic pumps 33, 34, so that the resistive pressure detected by the pressure detector and the actual discharging pressure of the hydraulic pumps 33, 34 detected by the current detector are compared and the motor drive circuit

41 of the hydraulic pumps 33, 34 is controlled according to the difference.

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